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Research Article

Productivity Gap and Profitability Analysis of Field Pea Under Front Line Demonstration in Selected Districts of Western Oromia, Ethiopia

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Abstract

The activity aims to demonstrate and evaluate field pea technology in selected districts of Jimma Arjo and Chaliya of Western Oromia. Accordingly; Jirraaf variety was planted along with a standard check Jiidhaa on adjacent plots of 10m*10m each, adhering to all agronomic recommendations. At maturity, participatory variety evaluation was done using important traits set by the farmers to select the best variety, selected Jirraaf first. Among the other traits listed, yield, disease tolerance, number of pods per plant, number of seeds per pod and seed color, were the first five most importantly considered and ranked traits by farmers to evaluate the best field pea variety Mean yield of 21.33 qt haand 16.29; respectively, for Jirraaf and Jiidhaa varieties ($p<0.05$); Jirraaf exhibited 30.93%yield advantage over Jiidhaa variety. Technology gap and technology index of 5.26 qt and 19.78% while 7.98 qt and 32.88%; respectively, were for Jirraaf and Jiidhaa varieties; confirmed more feasibility of Jirraaf to the farmers. Further, net gain and cost-benefit ratio of 235,460 ETB per haand 11.48 while 174, 980 ETB per haand 8.53; respectively, were for Jirraaf and Jiidhaa varieties, more profitability of Jirraaf variety Hence; Jirraaf variety has met the farmers' need it is vital recommending to scale up of the variety with its full package to the farmers in the study area and other areas with similar agro-ecologies in the future.

Keywords

Field Pea, Jiidhaa, Jirraaf, Participatory Demonstration and Evaluation, Technology Index, Technology Gap

1. Introduction

According to [1] center of origin/diversity of field pea (Pisum sativum L) are East Africa and West Asia with secondary center in South Asia and South and East Mediterranean sub-regions. The species P. sativum is dominant in Ethiopia even though wild and primitive forms are also known to exist in the high elevation of the country [2]. Field pea produced in various regions and widely grown in north, south, west and central parts of the country including, pocket areas in highlands and mid highlands with altitude ranging from 1800-3000 m.a.s.l. Generally, it is a crop of manifold merits in the economic lives of the farming communities of high lands of Ethiopia. It is a rich source of protein (25%), carbohydrates (12%), vitamins A and C, calcium and phosphorus, apart from having a small quantity of iron. Peas being very rich in proteins are valuable for vegetable purposes. Besides; according to [3], in areas

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where mono cropping is a dominant practice the crop has double advantage in terms of fixing atmospheric nitrogen and it serves as a "break crop" to diseases and pests when rotated with cereals.

The rank of field pea among the worldwide pulse is second [4, 5] and field pea with other food legumes covers about 13.24% of the total 12.49 million hectares of crop areas in Ethiopia and is the 4th most important stable food legume among the highland pulses in rural Ethiopia [6]. According to [6], in Ethiopia field pea covers about 221, 415.67 ha of the total arable land with a total production of 3, 233, 901.34 qt. This constitutes about 13.40% of the total area covered by pulses and 11.68% of the total annual production of pulses in the country. In addition in Oromia region, the total production was 1,409,959.49 qt for the same year. Therefore, the contribution of the Oromia region for the country production was 44%. The total area cultivated by field pea for the season 2021/22 in East Wollega and West Shewa zones were 2,563.80 ha and 7,257.28 ha; respectively.

Even though the above facts clearly show the important role the crop plays in the country's agriculture, the average national productivity (1.7 t/ha) is very low [7] when compared with the crop potential yield (3.556 t/ha) and (4.17 t/ha) research finding in Ethiopia reported by [8, 9]; respectively and the higher yielder (7-8 t/ha) reported at some European countries [10]. The estimated average productivity of field pea in Oromia Region is also very low; 16.90 qt/ha in 2021/22 [6] The major reasons are: very limited availability of improved seeds, susceptibility of the landraces to array of diseases, inherently low yield potential of the landraces and poor management practices and most pulse crops are grown from unimproved cultivars with low genetic potential. To this end, actually BARC has recently released new variety; Jirraaf with yield potential of 26.80 qt/ha and yield advantage of 10.4% to revert the scenario and alleviate the problem of low productivity as well as co-related challenges sustainably [11]. Consequently; cognizant that it is paramount important to demonstrate and disseminate this recently released field pea variety; high yielding, disease tolerant and quality variety (Kik type) under farmers' condition to make them competitive in the today's competing markets. Hence; the activity was initiated with these underlying objectives:

Objectives

1) To evaluate the productivity and profitability of the technology under farmers' condition;
2) To create awareness on the importanceand availability of the technology;
3) To collect feedbacks from the stakeholders for further research design and the way forward.

2. Materials and Methods

2.1. Site and Farmers' Selection

This activity was conducted in selected districts of West Shewa and East Wollega zones of Western Oromia. Selection of the districts was based on potentiality for field pea production. Accordingly, Chaliya and Jimma Arjo districts were selected based on the aforementioned criteria. One potential kebele from each district was selected and in each kebele 1 farmer's research group (FRG) comprising of 15 farmers was established. Three (3) hosting farmers from each of the district were selected to undertake the activity in collaboration with experts and development agents (DAs) of the respective district agriculture office. Selection of the farmers were based on good history of compatibility with group dynamics, possession of suitable and sufficient land to accommodate the trials, good history of handling experimental plots in the past and genuineness and transparency to explain the technology to others and vicinity to roads so as to facilitate the chance of being visited by many farmers.

2.2. Provision of Training

After sites and farmers' were selected both theoretical and practical training were given to farmers, DAs and district experts. The aim of training was to create awareness and training provided on the following areas; such as, field pea production management, breeding aspect, post harvesting (seed quality).

2.3. Planting

After the plots were properly ploughed and made ready for planting all necessary inputs (seed, fertilizers) were distributed to the farmers. Planting was made on the farmers' field by BARC researchers, technical assistants (TAs), DAs as well as FRG farmers.

2.4. Design of the Activity and Agronomic Management

Two field pea varieties; one newly released variety, Jirraaf against Jiidhaa as a standard check was planted on adjacent plots of 10m*10m each. All the necessary recommended agronomic practices 150 kg/ha seed and 100 kg/ha NPS were equally applied for all of the plots. Every field were supervised to check the status and to identify gaps.

2.5. Data Collected

For this activity all the necessary qualitative and quantitative data were collected. The collected data includes yield data, total number of farmers, DAs, experts and other stakeholders participated on training and field visits, farmers' perception on the attribute of the technology and costs and income gained.

2.6. Data Analysis

The data was analyzed using descriptive statistics such as mean, frequency distribution, tables and percentages. Also

quantitative data collected were subjected to SPSS software to analyse mean, standard deviation and t-test. Besides; score ranking techniques was used to rank the most important traits considered to evaluate and select best bet variety and/or technology to real situation of the area. Further, financial analysis was employed to summarize profitability of the technology under farmers' condition. Furthermore; technology gap and technology index were also used and according to [12], technology gap and technology index could be calculated using the following formula. To this end, the technology gap and index of demonstrated varieties were calculated using formulas (1) and (2) and presented Table 6.

Potential yield is the maximum possible yield obtained when the crop is grown using research recommended management practices [13]. For this study, the crop potential yield data was taken from the Crop Variety Registry Book [11].

Technology gap

Technology gap indicates that the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in fertility, acidity, rainfall and other natural calamities [14]. According to [14] its contribution is to narrow down the gap between the yields of different varieties and to provide location specific recommendations. It means the difference between the potential yield and the yield of the demonstration plot.

$$\text{Technology gap} = \text{Potential yield qt/ha} - \text{demonstration yield} \quad (1)$$

Technology Index

It indicates feasibility of the evolved technology on farmers' fields. The lower the value of technology index, the higher is the feasibility of the improved technology.

$$\text{Technology index} = \frac{\text{Potential yield} - \text{Demonstration yield}}{\text{Potential yield}} \times 100 \quad (2)$$

3. Result and Discussion

3.1. Participatory Variety Evaluation and Selection

The aim of participatory technology evaluation and promotion is not only maximizing yield but to improve actors' involvement in selecting technologies that fulfill their preference for sustainable technology diffusion [15]. Correspondingly; at maturity the varieties were then be evaluated based on the farmers' selection criteria. At this juncture, the farmers were assisted to jot their down evaluation criteria, which then be ordered using score ranking technique. To this end; farmers' evaluated each variety for individual traits, against the weight attached to each of the trait considered important, and ranked the varieties on a scale of 1-5, 1 being very poor and 5 being the highest score, superior. Accordingly; yield, disease tolerance, number of pods per plant, number of seeds per pod, seed size and maturity time were considered as the most important traits for evaluation and selection. At the end of the evaluation process, result of the evaluation was displayed to the evaluators and discussion was made on the way ahead. Based on overall mean score the best variety selected will be recommended to scaling up.

3.1.1. Field Pea Varietal Traits Pair-wise Ranking Matrix

Varietal traits considered very important were listed by the evaluators on participatory evaluation and selection; thereby ranked the principal traits, against the weight attached to each of the traits, among others listed to evaluate and select best performing varieties. Hence; through this process field pea varietal traits ranked summarized and presented Table 1 and accordingly; yield, disease tolerance, number of pods per plant, number of seeds per pod and seed size were the 5 top ranked and regarded mostly important among others. Thus; as farmers evaluation and selection criteria were beyond quantitative traits (yield), breeders should give equal consideration to qualitative traits (such as disease tolerance, seed color and others) in their breeding programs in general and in course of variety development in particular.

Table 1. *Field pea varietal traits pair-wise ranking matrix.*

Criteria	1	2	3	4	5	6	Freq	Rank
1		1	1	1	1	1	5	1st
2			2	2	2	2	4	2nd
3				3	3	6	2	3rd
4					4	4	2	3rd
5						6	0	6th
6							2	3rd

Criteria: 1= yield, 2= disease tolerant, 3=number of pods/plant, 4=number of seeds/pod, 5=early maturity, 6=seed size

3.1.2. Field Pea Varietal Score Ranking

Below (Table 2) presented field pea varietal score ranking of the districts. Accordingly; the highest score of 4.75 for Jirraaf variety; whereas, the lowest score of 3.40 for Jiidhaa

variety; hence; Jirraaf variety ranked first on overall mean score.

Table 2. Field pea varieties score ranking across the districts.

Variety	Chaliya			Jimma Arjo			Overall Rank
	Total Score	Mean score	Rank	Total Score	Mean score	Rank	
Jirraaf	28	4.67	1st	29	4.83	1st	1st
Jiidhaa	21	3.50	2nd	20	3.33	2nd	2nd

Criteria: 1= yield, 2= disease tolerant, 3=number of pods/plant, 4=number of seeds/pod, 5=early maturity, 6=seed size

3.1.3. Reasons for Varietal Ranking

Table 3. Reasons for varietal ranking on farmers' selection criteria.

No	Varieties	Rank	Reasons
1	Jiidhaa	2nd	Low yielder, susceptible to disease, few pods per plant (5.5), few seeds per pod (4)
2	Jirraaf	1st	High yielder, disease tolerant, many pods per plant (9), many seeds per pod (6)

3.2. On Farm Yield Performances and Yield Advantage of the Varieties

In spite of the inevitable variability in performance between and even within locations, performances of the varieties were still promising. Accordingly; mean yield of the vanities summarized Table 4; hence; mean yield of 21.33 ± 0.50 qt/ha and 16.29 ± 0.41 qt/ha; respectively, for Jirraaf and Jiidhaa varieties ($p<0.05$) and the result in line with the findings reported by [16]; Jirraaf variety ensured 30.93% yield advantage over Jiidhaa and 26.21% over the regional productivity of field pea 16.90 qt/ha [6]. Thus; Jirraaf variety is high yielding and more promising than Jiidhaa variety. The higher yield for Jirraaf variety was due to adoption and use of latest high yielding varieties together with improved management practices. Similar results were reported by [17] and [18] on the use of improved common bean varieties, had a significant yield advantage over the standard check.

Table 4. Mean yield of field pea varieties.

Variety	N	Mean	SD	Min	Max	Yield Advantage
Jirraaf	6	21.33 ± 0.50	1.49	18.36	23.47	30.93
Jiidhaa	6	16.29 ± 0.41	1.21	14.44	18.11	

Moreover, t-test on mean yield summarized Table 5 showed highly significant difference at ($p<0.05$) between the varieties.

Table 5. Mean yield comparison (t-test) for the varieties.

Variety	Mean	SD	T value	P value
Jirraaf	21.33 ± 0.50	1.49	7.46	0.0001

Variety	Mean	SD	T value	P value
Jiidhaa	16.29 ± 0.41	1.21		

3.3. Technology Gap and Technology Index

3.3.1. Technology Gap

Technology gap indicates that the gap in the demonstration yield over potential yield. As summarized and depicted Table 6 the yield gap is 5.26 qt/ha and 7.98; respectively, for Jirraaf and Jiidhaa varieties. The lowest gap was in Jirraaf variety revealed the demonstration yield was very close to the potential yield; which in turn shows better adaptability of Jirraaf variety in a particular area,; whereas, higher yield gap was for Jiidhaa variety. Thus; to fill this gap location specific recommendations are mandated. The technology gap might be attributing to the dissimilarity in soil fertility status, agricultural practices and weather conditions and similar findings were reported on by [19] and [20].

3.3.2. Technology Index

The technology index indicates the feasibility and demonstrates the viability of the evolved technology in the farmers' fields. Accordingly; technology index presented Table 6 were 19.78% and 32.88% for Jirraaf and Jiidhaa varieties; respectively, lower value in Jirraaf variety confirmed feasibility; the efficacy of good performance of technologies demonstrated, on farmer's field. The gap in technology index may be attributed to the difference in soil fertility status, agricultural practices, weather conditions, disease and insect-pests attack in the crop. This is in the tune of [21] and [22].

Table 6. Technology gap and index for field pea varieties.

Parameter	Field pea varieties	
	Jirraaf	Jiidhaa
Yield gap (qt/ha)	5.26	7.98
Technology index (%)	19.78	32.88

3.4. Financial Analysis

Financial analysis summarized Table 7 revealed an average return and cost-benefit ratio of 235,460 Birr per ha and 11. 48; whereas, 174, 980 Birr per ha and 8.53; respectively, from Jirraaf and Jiidhaa varieties in the study area; confirmed the highest profit and cost-benefit ratio for Jirraaf variety than Jiidhaa variety. Further; the cost-benefit ratio ensured farmers can generate 11. 48 ETB and 8.53 ETB benefit from using Jirraaf and Jiidhaa technologies for 1 ETB investment on cost of production. Furthermore; an extra Birr of 60,480 per ha-could be gained, if farmers produced Jirraaf variety. The higher net returns might be attributed to adoption of improved technologies resulted in higher yield; which in turn leads to higher profit. Similar results were reported by [20].

Table 7. Financial analysis of field pea varieties.

Variety	Yield (qt/ha)	Market price (Birr)	TVC	TR (P*Q)	GM (Profit)	C: B ratio
Jirraaf	21.33	12000	20,500	255,960	235,460	11.48
Jiidhaa	16.29	12000	20,500	195,128	174,980	8.53

3.5. Training

Training and mini-field days have facilitated the technology transfer from research to large extension. Hence, agricultural extension service should concentrate on the capabilities of end users [23]. Accordingly; stakeholders' participated on training summarized Table 8 and totally 44; 30 farmers (Me=24, F=6), 8 DAs (M=7, F=1) and 6 experts (M=6).

Table 8. Gender disaggregated stakeholders' participants on training.

Training Topic	Participants									
	Farmers			DAs			Experts			Total
	M	F	Total	M	F	Total	M	F	Total	
Field pea production and management	24	6	30	7	1	8	6	-	6	44

3.6. Mini Field Visit

Field day is one of the extension methods used to convey information and creation awareness for larger clients and which bad and good practices evaluated on the field [24]. Accordingly; stakeholders' participated on mini field visit summarized Table 9 and a total of 74 participants; 58 farmers (M=47, F=11), 8 DAs 9M=7, F=1) and 8 experts (M=8).

Table 9. Gender disaggregated stakeholders' participants on mini field visit.

Stakeholder participants on field visit						
Farmers		DAs		Experts		Total
M	F	M	F	M	F	
47	11	7	1	8	-	74

3.7. Farmers' Perception on the Technology

Farmers' valued Jirraaf variety; high yielder, disease tolerant, many pods per plant (9), many seeds per plant (6), seed size.

4. Conclusion and Recommendation

This pre-extension demonstration of improved field pea technologies was carried out in two selected districts; Jimma Arjo and Chaliya, of East Wollega and West Shewa zones of Western Oromia. One recently released field pea variety (Jirraaf) was planted on adjacent plots against standard check; Jiidhaa, on 10m*10m, totally on 6 farmers in the districts. In addition; mini field visit was also arranged for farmers' and other stakeholders' to collect feedback, create awareness on the availability and importance of the proven technology as well as to enable the stakeholders' participants participated on the event to share their valuable experiences among each others.

Further; at maturity stage participatory variety evaluation and selection was organized so as to rank traits considered important to evaluate and select best variety really suits to existing situation. Accordingly; Jirraaf variety was ranked and selected first; as it suited the farmers' selection criteria entirely listed for evaluation of the varieties and then Jiidhaa variety. Moreover; Jirraaf variety was far better in farmers' preference rank, yield, financial profitability and statistically highly significant difference at ($p<0.05$) on mean yield of the varieties. Further; lesser values of technology index dictate more feasibility of the variety to farmers. Eventually; based on feedback of farmers' evaluation results they selected Jirraaf variety then Jiidhaa variety. Therefore; based on farmers' keen interest on the variety and merits acquired by the variety it will be vital recommending to promote for large scale production along with full production packages. Thus; this necessitates scaling up the technology on large scales as a prior in the study area and other similar agro-ecologies beyond.

Abbreviations

BARC	Bako Agricultural Research Centre
CSA	Central Statistical Agency
DAs	Development Agents
FAO	Food and Agricultural Organization
FRG	Farmers Research Groups

MoA	Ministry of Agriculture
SPSS	Statistical Packages for Social Sciences

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Author Contributions

Effa Wolteji: Conceptualization, Formal Analysis, Investigation, Methodology, Supervision
Berhanu Soboka: Data curation, Supervision
Dubiso Gachano: Data curation, Supervision
Matewos Kasahun: Data curation, Supervision

Conflicts of Interest

All authors declare that they have no conflicts of interest.

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